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Gabriela Olivares-Cuhat
University of Northern Iowa

Michelle H. Ploof

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Recommended Citation

Olivares-Cuhat, Gabriela and Ploof, Michelle H., "The Role of Working Memory among Non-Traditional Foreign Language Students" (2017). *Faculty Publications*. 4.
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The Role of Working Memory among Non-Traditional Foreign Language Students

Volume 12, 2016-2017

Role of Working Memory among Non-Traditional Foreign Language Students
Gabriela Olivares-Cuhat and Michelle H. Ploof

Abstract

Over the last 40 years, a growing number of nontraditional students have joined the ranks of higher education. However, due to a number of internal and external factors, these students face multiple social, economic, and academic challenges that may limit their success in postsecondary education. The focus of this article is to examine the implications of these challenges on the learning of a foreign language (FL), and more specifically on the role played by working memory (WM) with nontraditional FL learners. To this end, research studies in the fields of psycholinguistics, cognitive psychology and neuroscience are reviewed and their findings are analyzed to uncover meaningful relationships between WM and FL learning among nontraditional students. To conclude, FL teaching methodologies and guidelines are recommended.

Introduction

1. The demographic profile in U.S. colleges and universities has evolved significantly over the last 40 years, as a steadily growing number of undergraduate students can now be described as nontraditional. This category encompasses a population with diverse attributes, such as having postponed university enrollment after high-school graduation, having dependents, being employed, and being generally older than 25 years of age (Choy, 2002; Provasnik & Planty, 2008). These students typically face specific challenges, such as the demands of raising a family, a rigid work schedule, transportation requirements, the need to relearn academic material and reacquire study habits, as well as the effect of age on cognitive processes, all of which may lead to accrued stress and lower performance in the classroom. Under these conditions, foreign language (FL) courses are often set as a graduation requirement by most institutions of higher education. Accordingly, distinct demands encountered by nontraditional students in the learning of a FL ought to be given some special consideration, for instance through the selection of suitable instructional strategies. In this context, the authors examine the role played by working memory (WM) on FL learning in nontraditional students, a factor that is increasingly viewed by researchers as a major contributor to achieving language proficiency (Hummel, 2009). To reach this goal, research studies in the fields of psycholinguistics, cognitive psychology and neuroscience are reviewed and their findings are analyzed to uncover meaningful relationships between WM and FL learning among nontraditional students. Finally, teaching guidelines and strategies are suggested.

Traditional and nontraditional students

2. Over the past decades, the proportion of nontraditional undergraduate students enrolled in postsecondary institutions in the United States has increased steadily. For example, enrollment rates for adults ages 25 to 34 nearly doubled from 1970 to 2010, while they increased by a factor of 1.8 for adults' ages 20 to 24; also, 3.3 times more part-time students were enrolled in 2010 than in 1970, against a factor of 2.3 for full-time students (Aud et al., 2012). In addition, taking into account both age and enrollment status, Kuenzi and Stedman (2005) established that almost 4 out of 10 undergraduate students could be classified as nontraditional.

3. Currently, there is no general agreement on which criteria sets apart traditional from nontraditional students, but the most common practice is to use age (i.e., younger versus older than 24 years old) and enrollment status (i.e., full-time versus part-time) to make this distinction (Wyatt, 2011). An advantage of these descriptors is that they are usually associated with the presence of other traits that commonly define the profile of nontraditional students, including employment and family situation (Kuenzi & Stedman, 2005). A more encompassing definition identifies nontraditional students on the basis of the following seven features: delayed enrollment after completion of high school, part time enrollment for at least a part of the academic year, full-time employment, financial independence, dependents in addition to a spouse, single parenthood, and no high school diploma (Choy, 2002). Kuenzi and Stedman (2005) also observed that nontraditional students were more likely to attend two-year public colleges, to be part of a minority, and to have a relatively low income. Otherwise, Pattillo (2011) suggested that student veterans could be viewed as a subgroup among nontraditional students (based for instance on their older age and financial independence).

4. Given the increasing numbers of nontraditional students pursuing a postsecondary education, it is critical for institutions of higher learning to adapt their procedures and methods in order to mitigate the specific educational challenges facing this population. To this end, a first step taken by researchers was to identify the nature of such barriers.

5. A first category of barriers could be defined loosely as depending on external factors and can be described with the help of a classification proposed by Cross (1981). In her view, factors that may discourage the participation of adults to postsecondary education can be categorized as situational, institutional, and dispositional. While these categories were proposed in relation to student's participation, they can also be used in reference to academic success. Accordingly, situational issues involve personal circumstances often found among nontraditional students, such as time pressures related to job and family responsibilities, financial instability, access to transportation, and single parenting. Clearly, these circumstances may impede on the learning process of nontraditional students, as they may affect their ability to meet course deadlines, study efficiently, and assimilate content. Institutional barriers relate to rules and procedures that preclude nontraditional students of fully participating in academic life. Such factors include inconvenient schedules, incomplete course offerings, lack of transportation, and inadequate information on university programs and regulations. Again, these conditions can clearly have a negative impact on the ability of nontraditional students to reach their full academic potential. The third type of hindrance, referred to as dispositional, causes nontraditional students to feel out of place in an academic environment and harbors doubts on their capacity to learn. Such

perceptions can be detrimental to the academic performance of nontraditional students as they undermine their confidence in their learning abilities.

6. A second category of challenges, which could be described as internal, are linked to the aging process and its influence on cognition. It is a generally accepted view that "older adults tend to find it more difficult to learn and remember new information than young adults" (Kliegel & Altgassen, 2006, p. 112). However, research has shown that these trends are more complex than that. In this respect, a useful theoretical framework was developed by Cattell (1963), who made a distinction between two types of general intelligence, fluid and crystallized. Fluid intelligence can be defined as:

The use of deliberated and controlled mental operations to solve novel problems that cannot be performed automatically. Mental operations often include drawing inferences, concept formation, classification, generating and testing hypothesis, identifying relations, comprehending implications, problem solving, extrapolating, and transforming information. (McGrew, 2009, p. 5)

On the other hand crystallized intelligence can be viewed as:

The knowledge of the culture that is incorporated by individuals through a process of acculturation. [It] is typically described as a person's breadth and depth of acquired knowledge of the language, information and concepts of a specific culture, and/or the application of this knowledge. (McGrew, 2009, p. 5)

7. A number of studies have shown that these two types of intelligence evolve differently with aging. Namely, fluid intelligence was found to decline with age (Bugg, Zook, DeLosh, Davalos, & Davis, 2006; Horn & Cattell, 1967), while crystallized intelligence appears to increase, or at least remain stable over the years (Horn & Cattell, 1967; Schaie, 2005). Altogether, it has been suggested that the decay in fluid intelligence could be gradually compensated by the growth of the crystallized component, so that little changes in overall intelligence would be observed until the age of 61 (Cross, 1981). Yet, in this context, it has been pointed out that traditional postsecondary instruction is generally designed to accommodate the learning strengths of young students, as a typical course content at this level usually involves vast amounts of new data that need to be processed, acquired, and stored rapidly, tasks that rely more heavily on fluid intelligence (Cross, 1981). In other words, older learners may be faced with some cognitive barriers that could put them at a disadvantage in an academic learning environment.

8. Foreign language is a graduation requirement set by most institution of higher education, so that nontraditional students are usually faced with the need to include FL classes in their plan of study. In this respect, it is often assumed that age will generally make it harder for this cohort to acquire a FL, making this demand an additional type of barrier to the academic success of nontraditional students. Is this assumption actually accurate? While many studies have investigated the effect of age on FL learning, only few have focused on the population of adult learners, i.e., those who are eligible to pursue higher education programs. For example, within the framework of a large study of Spanish and Chinese speaking immigrants to the U.S. with age of onset ranging from 0 to 70 who had 10 or more years of exposure to the second language,

Bialystok and Hakuta (1999) identified a steady decline of language proficiency in function of age as measured by a self-reported form. Birdsong and Molis (2001) found a similar trend correlating age of arrival and grammaticality judgment among Spanish learners of English as a second language with age of arrival ranging from 3 to 44. In another large-scale study using data sampled on immigrants to the US originating from a wide range of countries, Stevens (1999) reported that the proportion of immigrants claiming to speak English very well decreased steadily with age of arrival, a trend that was captured up to ages of 40. In contrast, a third empirical research conducted with the participation of adult Russian immigrants who learned English in the US and Hebrew in Israel did not reveal a correlation between age of arrival and level of ultimate attainment (DeKeyser, Alfi-Shabtay, & Ravid, 2010). Thus, empirical evidence seems to indicate that the ability to learn a FL either declines or at least plateaus above the age of 25 years. In a research report, Joiner (1981) referred to several empirical studies to link the decline of FL learning efficiency with age to concurrent changes in fluid and crystallized intelligences. In her view, the role of fluid intelligence in the FL classroom is associated to "rote memorization, the ability to learn through analogy, and verbal reasoning" (p. 10). On the other hand, she suggested that crystallized intelligence is more critical with respect to "vocabulary knowledge, general information, social situations, reading comprehension, and mathematical reasoning" (p. 10).

9. In summary, nontraditional students are faced with multiple challenges that may affect their academic success and attainment. This situation is reflected in the FL classroom and calls for specific teaching techniques and strategies. But which principles should guide such a task? In this respect, the transition from fluid to crystallized intelligence was noted as one of the major changes that seems to affect the learning abilities of nontraditional students. As it happens, many researchers have otherwise shown that the construct of fluid intelligence is strongly correlated with another concept closely related to FL learning, namely working memory (WM) (Ackerman, Beier, & Boyle, 2005; Colom et al., 2014). In the next section, a concise review of the literature on this conceptualization is presented.

Working memory, phonological memory and FL learning

10. Foreign language (FL) learning involves a range of mental processes that carry out various functions, such as attention, perception, rehearsal, metacognition, and memory. Such functions are assisted by a central component referred to as working memory (WM), which "combines the temporary storage and manipulation of information in the service of cognition" (Baddeley, Allen, & Hitch, 2010). The most accepted WM model today was originally proposed in 1974 by Baddeley and Hitch, who viewed it as a multicomponent system consisting of a central executive, a phonological loop, and a visuospatial sketchpad. A common way to describe the central executive component of this system is to compare it to the CEO of a company, who directs and connects necessary information for daily operational functions. The phonological loop is dedicated to sorting out verbal and phonological inputs, while the visuospatial sketchpad arranges data of visual and spatial nature. These two subsystems gather information on a short-term basis, aiding the central executive in "complex cognitive tasks such as reasoning, comprehension and certain types of learning" (Baddeley et al., 2000). A fourth component that was added later is the episodic buffer, whose role is to collect and combine information from various subsystems, including verbal and long-term memory (Baddeley et al., 2010). Short-term

memory (STM), or immediate recall, should not be confused with WM, of which it is a subset dedicated to the storage of information (Cowan, 1995).

11. With respect to FL learning, many studies have demonstrated that WM plays a significant role in explaining individual differences among language learners, and in doing so, the first step of such investigations was to define a metric to evaluate participants' WM effectiveness. The first step is to estimate the storage capacity associated with the phonological loop, also known as phonological memory (PM). Related tests include nonword repetition, word span, serial nonword recall, and serial nonword recognition (O'Brien, Segalowitz, Freed, & Collentine, 2007). For instance, nonword repetition requires for test subjects to repeat non words of varying syllable length. A second category of instruments, referred to as complex memory tests, involves the storage and processing of aural or written information to evaluate working memory capacity (WMC). Among such tools are Daneman and Carpenter (1980) Reading Span Test (RST) and Listening Span test (LST). In these activities, subjects are required to read and/or listen and understand several sentences, and then recall specific target words, e.g., the last word of each sentence (Juffs & Harrington, 2011).

12. Using these methods, significant links between WM and FL learning have been identified. A first set of investigations centered on the relationship between phonological memory and FL learning (See Ellis, 2008; Hummel and French, 2010; Juffs & Harrington, 2011 for reviews), and their findings generally supported the notion that PM correlated positively with the acquisition of a FL (Hummel & French, 2010). Papagno and Vallar (1995) studied the role played by PM and word learning abilities among Italian college students who were classified as polyglots and as nonpolyglots. The findings indicated that "polyglots had a superior level of performance in verbal short-term memory tasks (auditory digit span and nonword repetition) and in a paired-associate learning test, which assessed the subjects' ability to acquire new (Russian) words" (p. 98). This result indicated a "close relationship between the capacity of phonological memory and the acquisition of foreign languages" (p. 98). In another study, O'Brien, Segalowitz, Collentine, and Freed (2006) found that PM correlated with vocabulary scores, narrative abilities, and the use of grammatical morphemes and subordinate clauses in the course of a one semester class in Spanish (Pearson's r between .30 and .41, $p < .05$).

13. Subsequently, O'Brien, Segalowitz, Freed, and Collentine (2007) examined the relationship between PM (measured by a serial nonword recognition task or SNWR) and FL fluency (operationalized through temporal/hesitation-based oral measures: general oral ability and fluidity) among English-speaking college students taking Spanish classes (novice and intermediate level) in two different contexts, namely a study abroad program and a traditional classroom setting. These findings indicated that the SNWR correlated positively with measures of fluency for the entire cohort (Pearson's r ranged from .30 to .37, $p < 0.05$). For the study-abroad subgroup, SNWR correlated with four of the six measures of oral production (Pearson's r ranged from 0.35 to 0.44). For the at-home group, SNWR correlated with three of the six oral production measures (Pearson's r ranged from 0.48 to 0.62).

14. Similarly, Martin and Ellis (2012) studied PM and WM capacity and their relationship with vocabulary and grammar learning in an artificial foreign language. To this end, fifty adult English-speaking subjects first completed three memory measures (two tests for PM: nonword

repetition and nonword recognition; and one for WMC: a listening span test), then learned singular vocabulary items, phrases, and finally viewed plurals in a sentence without instruction. Subjects were thus evaluated on the production and comprehension of 50 new sentences. The findings demonstrated that nonword repetition correlated with vocabulary scores in production (Pearson's $r = 0.33$, $p < .05$) and in comprehension (Pearson's $r = 0.42$). It was also found that for a given exercise, the accuracy on the nonword recognition task correlated with the comprehension of vocabulary (Pearson's $r = 0.45$). As the researchers also looked at the relationship between memory and grammar learning, they found that the nonword repetition task correlated with all three grammar scores (composite, comprehension, and production) (Pearson's r from 0.34 to 0.43). Finally, the WMC measure correlated with all three grammar scores (Pearson's r from .35 to .46) and with the scores on the rule for describing plural formation (Pearson's $r = 0.33$).

15. In sum, research studies have shown the important role played by WMC and PM on the learning of a FL among students with different individual characteristics and skills. In the next section, the relationship between WM and the age of the students is examined.

Age and working memory

16. As noted previously, the concepts of crystallized intelligence and WM are closely related. Several empirical studies have confirmed that WMC tends to decrease with age (Borella, Carretti, & De Beni, 2008; Borella, Ghisletta, & de Ribaupierre, 2011; Cansino et al., 2013; Chiappe, Hasher, & Siegel, 2000; Fournet et al., 2012; Klaasen et al., 2014; Park et al., 2002; Salthouse, 1991).

17. For example, Borella, Carretti, and De Beni (2008) evaluated the change in working memory and other cognitive functions experienced by 304 Italian participants whose ages ranged from 20 to 86 years old. WM was measured with three instruments: a visuo-spatial task based on an adaptation of the Jigsaw puzzle test (Vecchi & Richardson, 2000), a first verbal task adapted from the Listening Span Test (Daneman & Carpenter, 1980), and a second verbal task derived from the Categorization Working Memory Span test or CWMS (Borella et al., 2008). The results demonstrated that age was negatively correlated with WM performance, with Pearson's r amounting to -0.74, -0.56 and -0.68.

18. In another investigation, Cansino et al. (2013) set out to identify the progression in time of visuo-spatial and verbal WM abilities. For six and a half years they tracked 1500 women and men whose ages ranged from 21 to 80. The findings indicated that the subjects underwent a substantial decrease in WM over time, "characterized by a significant rapid decline between the second and third decades in all tasks and by a second significant decline in the fifth and sixth decades" (p. 2299).

19. Additionally, Borella, Ghisletta, and de Ribaupierre (2011) studied age-related differences between young and older adults, especially with regard to the role of WMC in text comprehension. Eighty-nine young adults (mean age = 23.11) and one hundred and two older adults (mean age = 70.50) were presented with two WM tasks. The first measure assessed verbal capacity (a reading span test) and the second instrument evaluated both a verbal and a visuo-

spatial component (the matrices task). In the reading span test, participants were asked to read and judge simple sentences and recall the final word of each sentence. In the second task, the subjects recalled several words and their position in a given matrix. The findings indicated that WM correlated negatively with age ($r = -.0.71$) with respect to text processing.

20. Finally, Olivares-Cuhat (2012) conducted a comparative investigation of cognitive and affective learner variables between FL learners enrolled in beginning language courses offered in two different settings. The first group of 34 students was affiliated with a traditional residential institution, while the second group of 40 nontraditional students took night classes at an urban commuter university. Consistently with the abovementioned demographics, the median age of the first group was 20.5 years old, and the median age of the second group was 28.7 years old. An instrument called CANAL was included in the battery of tests to assess the language aptitude of the students (Grigorenko, Sternberg, & Ehrman, 2000). This was done by evaluating WMC through an immediate-recall measure. Olivares-Cuhat found that significantly lower immediate-recall scores were obtained by the older cohort of nontraditional students, with an effect size amounting to $d = 4.5$ (for effect size explanation, see Cohen, 1988).

21. In summary, previous research has demonstrated the existence of a negative correlation between age and WM. In the next section, the various relationships among nontraditional students, age, WM, and FL learning are considered with respect to the formulation of adequate pedagogical recommendations.

Pedagogical Implications and Recommendations

22. As a whole, this analysis sheds light on a chain of connected processes likely to affect the academic performance of nontraditional students in the FL classroom. First, nontraditional students are older. Second, an increase in age is accompanied with a decline in WM performance, a phenomenon that is found to be especially significant between the ages of 20 and 30 (Cansino et al., 2013). Finally, several studies have positively linked WM and FL. It can thus be inferred that a likely decline in WM among nontraditional students could explain, to some extent, how this group may experience greater challenges in the learning of a FL.

23. A first insight that can be gained is that instructional methods that are popular today in higher education may not be the best suited for the specific learning needs of nontraditional students., Starting in the 1980s, FL teaching became increasingly centered on the use of communicative methods, such as the natural approach, whose main objective is to use the FL in an authentic context. While they "tend to emphasize listening to and understanding messages in a primarily oral format" (Hummel & French, 2010, p. 381), for instance by stressing the use of dialogues, simulation, and role plays, these methods also require an intensive processing of phonological information in WM. As a result, the reliance on the oral input may stress the WM processing abilities of the nontraditional students due to a large amount of incoming data and the need to use word recognition skills and word retrieval strategies when comprehending and/or producing aural-oral material (Hummel & French, 2010). In other words, communicative methods may favor the agile mind of a younger student population, as they attempt to emulate the acquisition process of an L1, thus raising the concern that this path could add an undue burden on an older generation of students who may lack strong WM abilities.

24. Which language teaching methodologies would then be better suited to the nontraditional student? Following the suggestions of Gathercole and Alloway (2008), Hummel and French (2010), as well as Gregersen and MacIntyre (2014), such approaches should be aimed at lowering the demands on WM by relying instead on other mental functions. Along these lines, a first strategy could consist of using non-verbal cues to reinforce the meaning of words and sentences. This could be achieved for instance with the enactment process, in which gestures are performed to convey a message (Macedonia & Knösche, 2011), as this has been shown to enable the acquisition of concrete and abstract words through their association with physical motions, and thus not taxing WM resources (Yang, Gathercole, & Allen, 2014). Furthermore, this technique is equally accessible to individuals whose mental fluidity may show signs of aging, so that it could be especially appropriate for the nontraditional classroom. Another scheme could consist of conducting repetitive language drills, such as practicing syntactical and vocabulary patterns, as a way to facilitate the retention of the material. In doing so, this technique "may be of benefit for learners with low PM capacity who appear to have difficulty making and retaining accurate phonological representations" (Hummel & French, 2010, p. 382). Visual support is yet another way of reducing the dependence on communicative methods, as it may provide the learners with a reference frame that could free up WM resources. In addition, these types of tools could help focus the attention of the nontraditional students, who, understandably, may find it challenging to stay on task after, say, a day of work, and could then apply the capability of their WM more effectively toward the study of a FL.

25. Second, an effective instructional strategy dedicated to nontraditional students should take into account the detrimental effect that distractions and interruptions may have on WM performance. That such disturbances may play a preponderant role was established by many researchers (Dolcos & McCarthy, 2006; Logie, Zucco, & Baddeley, 1990; Tresch, Sinnamon & Seamon, 1993), who have shown that the adverse influence of external stimuli on WM performance grows significantly with age (Clapp & Gazzaley, 2012). In this respect, it is possible to draw a distinction between two types of interferences, namely distractions and interruptions. Various types of distractions could affect the nontraditional classroom, such as noise, late arrivals, and other disruptive behaviors, as well as the use of electronic devices for tasks unrelated to the learning process, as reading news articles or following twitter feeds. So, while such unnecessary disturbances should normally be avoided in the language classroom, the need to do so proves even greater in the nontraditional classroom in view of the lower WM ability of this group. As to interruptions, these are disruptions that may not be ignored and are thus forcing the students to shift their attention to a secondary task. Examples of such circumstances encompass phone calls and instant messages from dependents, abrupt digressions in classroom content and activities, as well as multitasking. Thus, teachers should avoid departing from the lesson plan to address unrelated topics, and not make use of techniques that require multilayered thinking skills, such as the creation of a role play without sufficient academic support.

26. A third factor that has been shown to affect WM is stress (Luethi, Meier, & Sandi, 2009; Rai, Loschky, Harris, Peck, & Cook, 2011; Schoofs, PreuB, & Wolf, 2008). This is a critical aspect in this context, as nontraditional students are likely to face stressful circumstances as a result of situational, institutional, and dispositional barriers. Consistently, one can infer that administrative and policy measures such as providing better accesses to financial aid, day care, transportation,

flexible class schedule, academic coordination, mentoring, and counseling services could help improve the academic performance of nontraditional students in the FL classroom.

27. In this study, the role of WM on FL nontraditional students was investigated by reviewing research conducted in the fields of second language acquisition, educational psychology, cognitive psychology, behavioral neuroscience, and FL teaching. As a result, it was shown that, in several respects, nontraditional students find themselves at a disadvantage. Indeed, the crucial role played by WM in FL learning combined with a possible decline in WM capacity along with age make it more difficult for this group to fully succeed. As it happens, this problem is exacerbated by the bias of popular FL teaching methods that favor communicative strategies, thus placing a higher burden on WM use. In addition, situational barriers such as increased disruptions and stress tend to further impair the use of this capability. These findings warrant a broad reexamination of the teaching methods currently used in the college language classroom.

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